Coil Displacements in RFOFO Ring

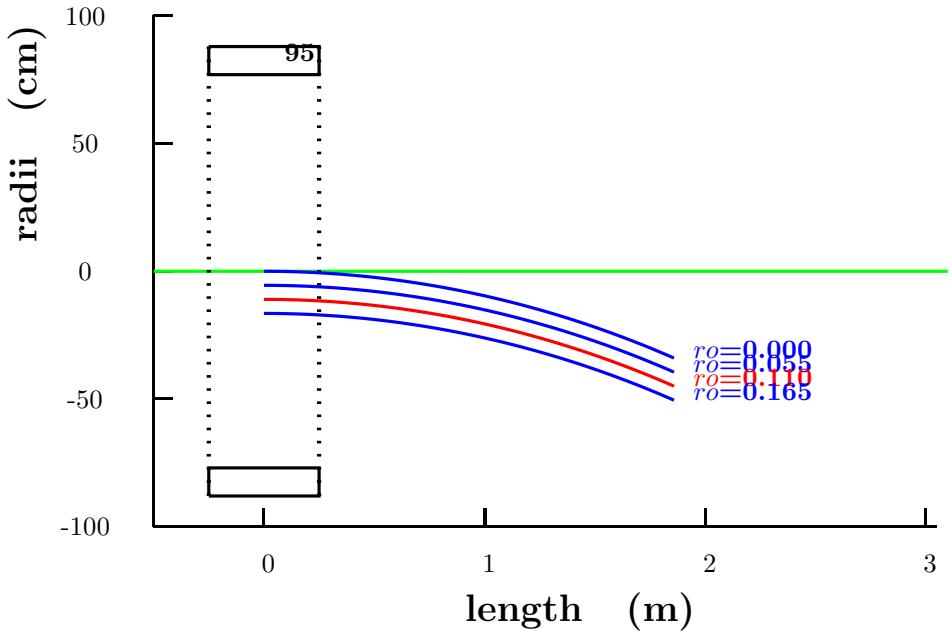
We look at the fields from a single coil along a curved orbits corresponding to circumferences=33 m (SA), and different transverse offsets (see Fig 1). A field map from ICOOL and a crude linear interpolator were used.

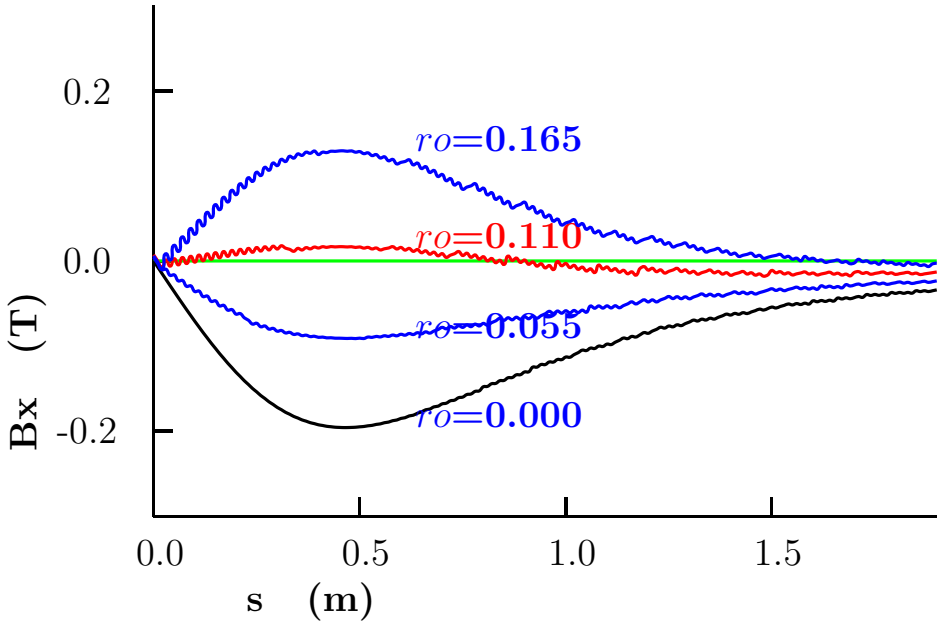
Vertically Bending Fields

When the beam orbit is close to this circle (black line), then these vertically deflecting fields are quite large (up to .2 T, compared with the average horizontally bending fields of 0.125 T). These fields can be largely removed by displacing (not yawing) the coils outward with respect to the beam circle SA.

You can see why. The field lines on a coil axis are straight, but if the beam orbit is curved, then before long the coil's axial field has an x component with respect to the orbit. But field lines starting at a point horizontally displaced from the coil center are themselves curved. We minimize the horizontal deflecting fields by displacing the coils so that the curving beam lies close to the curvature of these field lines.

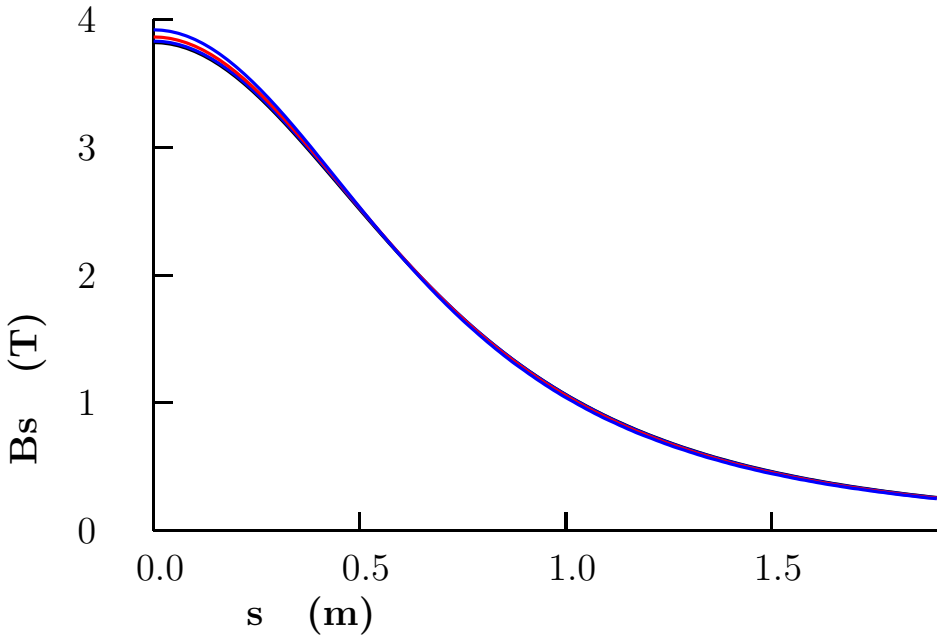
It is seen that an initial offset of about 11 cm is best, and lowers the horizontal fields to about .015 T: surely small enough. The real situation involves many coils that will, because they alternate, tend to smooth the effect. I do not expect a very different result.

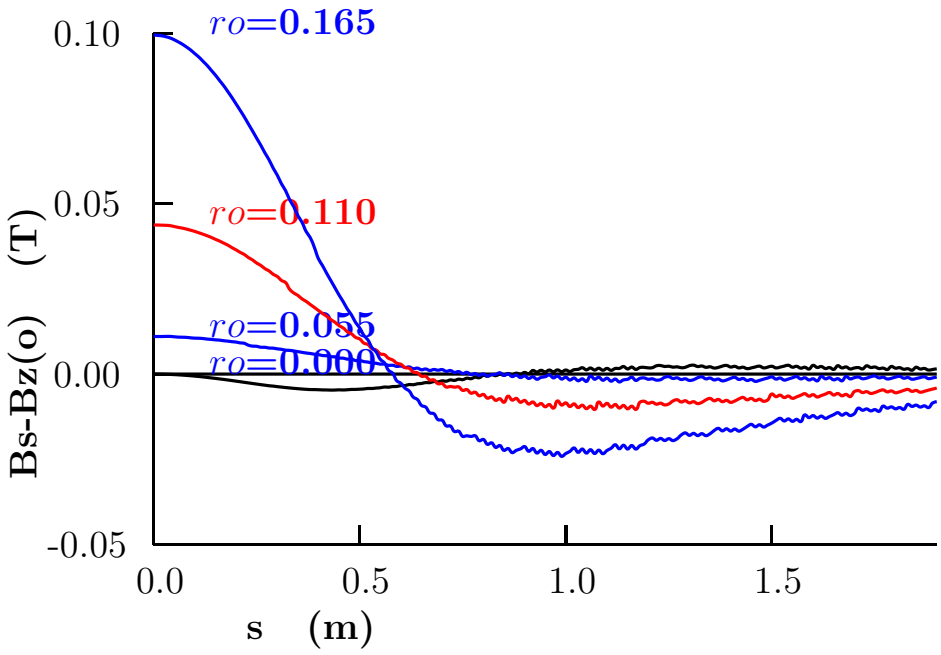

100
50
0
-50
-100
radii (cm)
95
ro=0.000
ro=0.055
ro=0.110
ro=0.165
0
1
2
3
length (m)


0.2
0.0
-0.2
Bx (T)
ro=0.165
ro=0.110
ro=0.055
ro=0.000
0.0
0.5
1.0
1.5
s (m)

Axial Fields

In the following plot we show the fiesld B_s along the displaced curved ideal orbits. It is seen that the displacements have relatively little effect. In the next plot these fields are compared with the axial fields along a straight central orbit $B_s(s) - B_z(z)$. It is seen that the effects are small (.04 T out of 4 T). They could be corrected, if required, by the use of slightly lower current (to lower the field at small s) in a slightly larger coil (to raise the fields at larger s).


4
3
2
1
0
Bs (T)
0.0
0.5
1.0
1.5
s (m)


0.10
0.05
0.00
-0.05
Bs-Bz(o) (T)
ro=0.165
ro=0.110
ro=0.055
ro=0.000
0.0
0.5
1.0
1.5
s (m)

Conclusion

j **My hunch is that, for our current RFOFO ring, the simple radial displacements will be enough. But future, more complicated rings (and Balbekov's current ring) will probably demand some real solver, as Rick suggests.**